Appendix F.
Biodiversity Pathways

By providing a range of forest structural stages, managed lands become more like natural forests in terms of their ability to support a diversity of wildlife species on a landscape or ecoregional scale. An approach for accomplishing this, proposed by the scientific community, is conservation of the biological diversity through manipulation of the stand structure. This approach is illustrated by biodiversity pathways (Carey and Curtis, 1996) as previously discussed and by variable retention harvest systems developed by Franklin (Franklin et al., 2002).

Carey et al. (1996) stated: "If we are to keep options alive for ourselves and for future generations, we must manage to conserve biodiversity. Conservation of biodiversity differs from single- or multiple-species management and single-commodity management. Biodiversity is different from species, taxonomic, structural, or habitat diversity. Conservation of biodiversity is the management of human interactions with the variety of life forms and ecosystems so as to maximize the benefits they provide today and maintain their potential to meet future generation's needs and aspirations." The Board of Natural Resources directed the department to implement biodiversity pathways in Western Washington in order to "simultaneously increase the production of trust revenue and complex forest habitat with a priority for habitat areas and across the landscape as appropriate" (Board of Natural Resources Resolution No. 1110, 2004).

The principal silvicultural strategies of biodiversity pathways are retention levels at final harvest, reforestation, thinning, and direct habitat quality improvements, e.g., snag/large woody debris creation, nest boxes, that target management of important stand cohorts in order to accelerate the structural development of each forest stand to best attain site-specific economic, ecological and social objectives. There will be a spectrum of various intensities of biodiversity and associated treatments that depend on the particular objectives for a stand or landscape.

Specific techniques include improved planting stock and variable density thinning. In variable density thinning, the stand is thinned to different residual tree densities, while snag and down woody debris cohorts are replenished. Heavy thinning treatments can typically result in less than 50 percent of the initial stand remaining after harvest. Also, some dominant trees are removed from the upper canopy to create sufficient space and gaps for the development of smaller trees (Carey et al., 1999). Without such thinning treatments in dense competitive exclusion stands, the density of dominant trees will not allow for the development of understory trees within the stand. Normally, these variable

density thinning treatments, both heavy and light, harvest across the diameter classes. For these reasons, variable density thinning does not necessarily result in lower stumpage rates than traditional thinning. The objective of variable density thinning and reforestation methods that encourage structural development is to increase the diversity of the trees that represent the largest cohort of trees within a stand.

A regeneration harvest will occur when landscape and stand objectives are met for a period sufficient in length to satisfy landscape objectives, i.e., revenue generation objectives are met and/or the stand has remained in a structurally complex state for a period of time that has allowed generation of another stand of sufficient structural complexity in the landscape. A regeneration harvest is the end of the rotation treatment before the stand is replanted or reestablished through natural regeneration.

The principles of the biodiversity pathways approach to silvicultural treatment (based on Carey et al., 1996, page 23) are to:

- Retain large-tree legacies (snags, large live trees and their epiphytes) and conservation of soil organic matter, seed banks and coarse woody debris and understory vegetation at harvest;
- Minimize site preparation, but under-plant widely spaced, site-appropriate and shade-tolerant species to supplement natural regeneration of tree and shrub species;
- Implement modified thinnings that retain patches and open up the forest canopy to encourage the development of a diverse and patchy understory that mimics that in old forests; and
- Directly improve habitat quality by creating cavity trees and adding coarse woody debris in the form of felled trees.

These principles call for a new silvicultural system that deliberately manages stand cohorts by rotation-length silvicultural prescriptions. Depending upon a stand's current condition, such as site and species composition, different combinations of treatments based on these principles would be applied at different stages during the rotation to maintain the stand on the desired pathway towards developing a structurally complex forest stand. The pathway is geared to optimally meeting these stand objectives.

The harvest treatments in the biodiversity pathways approach would typically be variable density thinnings that use a mix of heavy and light thinning, and regeneration harvests. The variable density thinnings would likely include a mix of heavily thinned areas, e.g., where less than 50 percent of the initial stand remains after harvest; lightly thinned areas, e.g., where more than 50 percent of the initial stand remains; small openings of approximately one-quarter to ten acres in size depending upon the stand conditions and objectives; and un-thinned areas.

Selecting the type of treatment and intensiveness of the thinning would be determined by site-specific conditions and stand objectives. For example, for the westside, analysis of current forest conditions, the riparian and wetlands areas and designated habitat management areas suggests that only about 35 percent of this area is suitable for long

(140-year) rotation silviculture with heavy thinnings. Suitability is defined as conifer-dominated stands that are not in a densely overstocked state. Thinning large-diameter closed (competitive exclusion) stands too heavily could lead to blow-down that may damage much of the existing forest structure, e.g., snags. In addition to the harvest treatments, the silvicultural prescriptions would likely include treatments to create and maintain snags, coarse woody debris and small openings.

Regeneration of stands within the biodiversity approach is determined by alternating maturity criteria. Forest stands with current conditions that can be managed with variable density thinnings on long rotations may have maturity criteria of 110 to140 years, depending upon the site, species and stand objectives. Forest stands that are currently over-stocked, i.e., have too many trees, and are beyond response to thinning without undue risk are not conducive to longer rotations with variable density thinning. These stands have earlier maturity criteria, between 40 to 70 years depending upon site, species and stand objectives. After their regeneration, these stands will be managed over long rotations.